The next column gives the diameter of field which often varies considerably with the objectives of same nominal power. The next column shows the flatness of field, indicated by an arbitrary standard of 1 to 6—the latter representing an *absolutely* flat field which I have not yet found in any objective I have examined. The next column shows the chromatic correction. I have been unable to devise any numerical method which would fairly represent the quality, and have been forced to content myself with such vague notes as "slightly under," "slightly over," etc.

The next two columns give the number of the diatom on Möller's balsam mounted "*probe platte*" clearly and fully resolved by the lens with light from lamp and mirror, and the number of lines per .001 inch as determined by Prof. Morley's measurements. The next two columns, the number of the diatom on same "*platte*" which could be just glimpsed under same conditions, and the number of its striae per .001 of an inch. The last column is for remarks.

It is of course understood that many of the results given would vary with different eye pieces, but all, except the actual amplifying power, have been obtained with Tolle's ½ inch solid eye piece, the field of which is small enough not to be affected by the size of the tube of the microscope.

I present herewith the results of my examinations of forty objectives of various makers. It was intended that the table should be as complete as possible, but at least two important omissions have been discovered as the work progressed—

1st.—The diameter of the exposed face of front lens should have been given.

2d.—The number of the diatom on the Möller platte resolved with direct *central* light should also have been recorded.

There are probably other points which have been overlooked, but the table is submitted as an earnest and honest endeavor to remove the examination of objectives from the domain of mere opinion to that of carefully ascertained and accurately recorded *fact*. The attempt has been to ascertain and record the details of the best performance of each objective for itself rather than to express an opinion as to its excellence or defects as compared with some standard, ideal or actual, and it is hoped that, not only these records but more especially the *method* may prove of interest and possibly of service to users and makers of objectives.

In conclusion I wish to express my thanks to the owners, dealers and makers who have kindly placed objectives in my hands for examination, and my regret that my limited leisure has prevented me from making the present exhibit more complete by including the work of other makers.

OBSERVATIONS ON LERNEOCERA CRUCIATA.

BY D. S. KELLICOTT.

Mr. A. M. Norman, in the *Zoologist* of London in 1864, remarks as follows: "Little has been done, as yet, in Great Britain among the external parasites of fish. The only work that treats of them is Dr. Baird's 'History of the British Entomostraca.'" It is fifteen years since the statement appeared, and yet it has

recently been repeated in substance by a writer in *Hardwick's Science Gossip*, and the remark applies with equal or greater force to the state of our knowledge, and to our literature of these strange creatures; while observations, researches and papers have appeared concerning higher forms of crustacea, those treating of these lower forms are characterized by their poverty. Few species have been described, especially among such as are parasitic on our fresh water fishes, while the habits and history of still fewer have been published. In this paper, I have attempted to state briefly the results of my study of the species *Lerneocera Cruciata*, of Lesueur, prefacing it with some general remarks about the group.

"Of all the curious creatures which the naturalist meets with in his researches," says Dr. Johnston, "there are none more paradoxical than the *lernæ;* none which are more at variance with our notions of animal conformation, and which exhibit less of that decent proportion between a body and its members which constitutes what we choose to call symmetry or beauty." This *outre* appearance pertains to the female principally, for the male, as a rule, is less monstrous than the female, and sometimes of as "decent proportion," as beautiful in outline, and as graceful in its movements as most others of the numerous forms of the free *copepoda;* this is true also of the females, until after they have passed some time, with the males, as free swimming crustacea. In the meantime, having undergone several moults, it is not until they reach maturity, the end of existence then being the perpetuation of the species, that they undergo the wonderful change which naturalists have been pleased to call a retrograde development. She increases enormously in size; the segmentation becomes almost wholly obliterated; the thoracic and abdominal appendages remain as minute organs, as rudimentary organs, or are transformed into powerful organs of attachment. To the females of the species of the group to which our lernæan belongs, the expression must apply if at all. Instead of the free-swimming, active individual, the female becomes fixed, the head and upper part of the thorax with the thoracic appendages, are buried beneath the skin and muscles, or other soft parts of the host, depriving her of the slightest power of locomotion; in fact, the females are so modified by the loss of apparent articulation and reduction of external organs that they were classified with worms, until the observations of M. Surriary and Alexander Nordman; the former in 1822 discovered the true nature of the external egg tubes, the latter, a little later, traced the life history of one species; since the appearance of the works of Milne-Edwards and Dr. Baird, their place among the *crustacea* has been generally understood. They certainly afford a remarkable example of adaptation of means for securing ends; an example of as complete passivity as it is possible to find amongst animals.

The adult female *cruciata* is a parasite upon the ROCK BASS (*Ambloplites rupestris,*) taken in the great lakes and tributaries. The species was described by C. A. Lesueur from specimens taken at Erie, Pa., in 1824, in the Journal of the Academy of Natural Sciences of Philadelphia. His description is as follows: "Body rectilinear, clavate, terminated by five tubercles which are rounded behind; head armed with four subcorneous appendices in the form of a cross and a little curved before."

Besides the formal description, he states some facts and conclusions. I introduce these: "Body slender toward the head, and gradually dilating behind, and so transparent as to exhibit the interior parts distinctly. At the extremity of

each of the head appendices is a small, black, impressed, somewhat oblong point, which may be an opening communicating with the interior. The intestinal canal extends the whole length of the body without folds or dilations, but gradually enlarges towards the posterior extremity. At a distance of about two-thirds the length of the body from the head, an annulated vessel originates and passes downwards on each side of the intestinal canal; this double vessel seems to unite at its superior part. The conformation of this vessel seems to indicate that it is an ovary, there being no appearance of such appendices to the posterior part of the body as exist in that of the following species, *L. radiata* and *L. Blainvillii*, and which probably perform the function of branchia. I have been led to suppose the existence of other openings in the tubercles through which respiration may be effected."

Concerning the transparency of the body walls, I observe that the older individuals are not sufficiently transparent for advantageous study of living examples; that the chitinous exterior together with the external load of confervæ and infusorial life which they usually bear, render them too opaque for satisfactory examination, but a young specimen, *i. e.*, one having recently completed its final change is beautifully transparent. It was from such that I was able to make my drawings with the camera, of the body, thoracic organs, and external ovary. With regard to the "small, black, impressed, somewhat oblong point" at the extremity of the head appendices, I must say that I have sought for it, without finding it, or anything else which could have been thus characterized.

There is no doubt that the "annulated vessel originating two-thirds of the length of the body from the head end, is the ovary," or rather, as they do not appear to be "united at the superior part," they are the ovaries; by a reference to the drawing it will be seen that they originate at, or reach to, about the middle of the body, and are at their anterior extremity, folded back upon themselves for about one-third their length. For the distance they are each double, they overlie the intestinal canal, and sometimes each other, which fact, no doubt, led to the expression, " unite at the superior part." Under favorable circumstances, the ova which gives them their annulated appearance, may be well made out. The absence of "appendices to the posterior part of the body" was due to an accident, for these are, as is well known, the external ovaries. I have, at different times, taken several females of this species with well-filled egg-sacs; still a majority of the older ones taken in July and August are without them, while those fertile ones taken at mid-summer have the eggs loaded with algæ and infesting infusoria. So I suspect the most favorable time for studying the embryology and preliminary stages is not during the summer months.

THE OVISACS.—The young specimens used for my drawings afforded clean pairs of egg-tubes which I describe as follows: Length 2.1 mm., greatest width .45 mm. The outline is fusiform, slightly curved inwards. There are about eight rows of eggs at the widest part, but two or three at apex (Fig. 1, *e*).

The place at which the parasite attaches itself to its host, is on the sides of the body; the majority occurring on the tail third. It is fixed thus: The body of the parasite issues from beneath a scale, or at the angle between two; the upper surface of the head and thorax resting close beneath the skin, with the upper side of the head, the mouth and appendages, together with the thoracic appendages resting next to, or within the flesh of the fish; about one-third the length of the body is inserted into the muscle, a *constriction indicating an articulation and bearing a pair of appendages*, marks the point to which it is concealed. This

oblique setting, together with the freer motion of the articulation, permits the body of the parasite to rest close to that of the fish when it moves through the water, exposing it less to injury from violent contact with objects.

After removal from the fish they exhibit little motion. The appendicular organs continue to move, and the intestinal canal continues to pulsate for some time; I have observed it twenty-four hours after removal. The alimentary canal, as said by Lesueur, can be traced from mouth to anus; it is a tube without folds, but somewhat dilated posteriorly; I am unable to detect accessory digestive organs. It contains a black granular matter, more apparent anteriorly. The canal is surrounded by a light, fine, granular mass, showing here and there oil globules; this mass moves back and forth with the canal, as adjacent parts of it thus move with its rhythmical pulsations; from the beginning of the ovaries to the head, this matter seems to fill the space between the canal and the body walls. In a fresh individual, I observed that the pulsations took place once in five seconds.

APPENDAGES.—It still remains for me to describe the appendages of the head and thorax. I will begin by referring to the last pair (Fig. 2). This pair stands on the under side of the posterior border of a segment at the most constricated portion of the neck (Fig. 1, *z*,). They consist of a basal portion, protopodite (*a*), on which stand two lamellar organs which I designate as endopodite (*c*), and exopodite (*b*). They are each three-jointed and bear long plumose setæ, for the detailed arrangement of which I refer to the figure; underneath the posterior border of the so-called head appendages is a similar pair (Fig. 1, *x*,); beneath the center of the head stands another pair quite like the other two (Fig. 1, *y*,). This pair is, however, smaller, and the parts stand quite near to each other; they are but a short distance back of the pair of foot-jaws (Fig. 3, *f*,), at the base of, or just below the mouth parts. These three pairs seem to be quite analogous in structure to the swimming feet of free *copepoda*. Their use may be to force from the wound such matter as the irritation produced by the action of the parasite may cause to settle there.

I first detected these organs in a female recently transformed; afterwards in older specimens after immersion for sometime in caustic potassa; finally in such specimens without treatment; in such, however, the two pairs nearest to the mouth are usually encumbered with foreign matter.

THE MOUTH.—The mouth appendages are arranged about a conical body, corresponding to the head, as I think, among higher forms, in the median line at the apex of the head; when under the compressor, it is bent under and then is directed backwards. I have been unable to define it in any other position so as to sketch it. This cone ends in a blunt point, at the opening of which several hooks appear, which I suppose represent the mandibles, although quite different in form from those parts in higher forms. On either side of the cone stand two organs, which I take to be the first and second pairs of antennæ. I describe them as follows: First pair, (Fig. 3, *a*,) three-jointed; the first joint as long as the other two, which are equal to each other; for arrangement of spines, refer to the figure. The second pair, (Fig. 3, *b*,) two-jointed; joints equal; setae at the termination long and hooked. Below the mouth opening, but reaching to it, is a pair of foot-jaws (Fig. 3, *f*). The articulations of these organs are hard to make out; the last joint bears at its apex five strong hooks; at its base is a thumb-like projection, and a styliform appendage. The specimens used in my observations were taken from rock

bass taken in the Shiawassee river, the Upper Saginaw, at Corunna, Mich. About one-fourth of the fish taken had one or more of the parasites. They are taken occasionally from the Niagara at Buffalo. I have diligently sought for the male without, as yet, finding him.

EXPLANATION OF THE FIGURES.

Fig. 1. Dorsal view of female; *e*, ovisacs; *o*, ovaries; *a*, alimentary canal; *m*, mouth; at *x*, *y* and *z*, are the appendages shown in Fig. 2.

Fig. 2. Thoracic appendage; *a*, protopodite; *b*, exopodite; *c*, endopodite.

Fig. 3. Mouth; *a*, first pair of antennæ; *b*, second antennæ; *n*, mandibles; *f*, foot-jaws.

SOME OBSERVATIONS UPON THE DESTRUCTIVE POWERS OF CERTAIN INSECTS.

BY C. M. VORCE.

Almost every microscopist is familiar with that interesting object, the "*proventriculus*" or gizzard of the cricket, as well as the corresponding organ of the cockroach, and doubtless the first has impressed most observers with its appearance of destructive power; indeed, to view its hard, sharp, knife-like teeth or processes and its remarkably powerful compressor muscles, reminds the observer of the resistless force of the quartz crushing mill. The question at once suggests itself: what purpose is this highly developed organ designed to serve in the general economy of nature? Its specific object in the insect's organization is plainly to cut and crush, in fact to masticate, the food taken into the stomach. But the cricket is not commonly classed as a destructive insect and is rather considered harmless, and so far as economic ends are concerned it appears to be harmless.

These reflections invite comparison of the masticatory and digestive apparatus of the cricket with that of the notoriously destructive locust, or grasshopper, the cockroach, and other destructive insects.

Starting with the harmless cricket, we should expect to find its destructive relative, the locust, armed with a terrible enginery of destruction, but on examination this expectation is not realized. The gizzard of the grasshopper (*Caloptenus*) is weakly, armed with but a single circlet of inconspicuous teeth, short and blunt, seemingly capable of but little crushing or cutting action. Nearly the entire œsophagus, however, of the locust is set with rows of numerous small, sharp, thorn-like teeth, almost exactly the shape of pike's teeth, pointing backward, and underlaid by longitudinal muscles which are apparently capable of action independently of each other, thus giving exactly the feed motion of the sewing machine. Near the gizzard these teeth are set on separate chitinous plates, three to seven teeth on a plate. Nearer the mouth they are set in long rows on longitudinal chitinous ridges and are longer than those on the plates. These thorn-like teeth can, however, effect little, if any, comminution of the food, and so far as

RECORD OF OBJECTIVES FOR TH

EXAMINED BY GEO. E. BLACKHAM, M. D., DUNKIR

Record No.	Owner.	Maker and When Made.	Price.		MAKER'S DESCRIPTION.							RESULTS OF ME									
			$	Cts.	Designation.	Cover Adjustment.	Dry or Immersion.	Equivalent Focal length.	ANGLE OF APERTURE Air.	Water.	Balsam.	Extreme Angle for Admission of Light Air.	War	Balsam.	True Aperture Extreme Angle for Good Definition Air.	Water.	Balsam.	Nominal Amplifying pow'r	Actual Amplifying power.	Frontal Distance.
1	Geo. E. Blackham, Dunkirk, N. Y.	R. B. Tolles, Boston, '76.	30	. .	1 in.	None.	D	1 in.	30°	. .	. .	30°	. .	. .	30°	. .	. .	10	10	.309
2	"	"	70	. .	Duplex ⅙	Coll. mov. back.	I	⅙	180°	. .	95°	180°	114° 35′	95°	180°	114° 35′	95°	60	54to75	.017
3	R. B. Tolles, Boston, Mass.	"	15	. .	Student ¼	Front Lens.	D	¼	110°	. .	. .	108°	. .	. .	108°	. .	. .	40	45	.015
4	Bausch & Lomb Optical Co.	B. & L. Optical Co., Rochester, '78.	15	. .	Student 1-5	None.	D	1-5	108°	. .	. .	108°	. .	. .	100°	. .	. .	50	50	.012
5	"	"	20	. .	1 in.	"	D	1	36°	. .	. .	36°	. .	. .	36°	. .	. .	10	8.33	.416
6	"	"	20	. .	4-10	"	D	4-10	110°	. .	. .	110°	. .	. .	100°	. .	. .	25	25	.021
7	J. W Queen & Co., Philadelphia.	Carl. Zeiss, Jena, '78.	15	. .	3-5	"	D	3-5	. .	. .	. .	36°	. .	. .	36°	. .	. .	16⅔	14	.281
8	"	"	19	. .	C. C.	"	D	¼	90°	. .	. .	90°	. .	. .	80°	. .	. .	40	36	.018
9	"	"	40	. .	G.	Coll. mov. back.	I	⅓	. .	108°	. .	180°	108°	90°	180°	99° 38′	84°	80	85to90	.015
10	"	"	47	50	H.	"	I	1-11	. .	108°	. .	180°	108°	90°	180°	102° 13′	86°	110	100 to 112	.012
11	Edward Pennock.	C. A. Spencer & Sons Geneva, N. Y. '78	15	. .	Profess'al 1 in.	None.	D	1	30°	. .	. .	33°	. .	. .	33°	. .	. .	10	10	.308
12	"	"	20	. .	Profess'al ½ in.	"	D	½	65°	. .	. .	65°	. .	. .	65°	. .	. .	20	22	.050
13	Bausch & Lomb Optical Co.	Bausch & Lomb Optical Co. '79.	18	. .	Student Gly. L. ¼	Front Lens	D	¼	105°	. .	. .	100°	. .	. .	100°	. .	. .	40	35	.016
14	"	"	28	. .	Profess'nl ⅙	Coll mov. back.	D	⅙	170°	. .	. .	140°	. .	. .	120°	. .	. .	60	60	.008
15	"	"	25	. .	½	None.	D	½	85°		. .	85°	. .	. .	85°	. .	. .	20	18½	.036
16	Geo. E. Blackham.	"	25	. .	½	Front Lens.	D	½	85°		. .	98°	. .	. .	92°	. .	. .	20	20to22	.026
17	John W. Sidle.	John W. Sidle, Philadelphia, '79.	10	. .	⅔	None.	D	⅔	34°		. .	32°	. .	. .	32°	. .	. .	15	15	.199
18	"	"	18	. .	3-10	"	D	3-10	110°		. .	120°	. .	. .	102°	. .	. .	33.3	33.5	.030
19	"	"	not	sta'	1-5	"	D	1-5				115°	. .	. .	81°	. .	. .	50	50	.022
20	Prof. A. H. Tuttle, Columbus, O.	C. A. Spencer & Sons Geneva, N. Y.	not	sta'	1	"	D	1	50°		. .	50°	. .	. .	50°	. .	. .	10	10	.137
21	R. & J. Beck, London & Philadelphia.	R. & J. Beck, London, Eng. '78.	27	50	3	"	D	3	12°	. .		12°	. .	. .	12°	. .	. .	333	3.	2.442
22	"	"	27	50	1½	"	D	1½	23°	. .	. .	23°	. .	. .	23°	. .	. .	167	6.67	.652
23	"	"	25	. .	⅔	"	D	⅔	32°	. .	. .	32°	. .	. .	32°	. .	. .	15	15	.325
24	"	"	60	. .	4-10	Coll. mov. front lens.	D	4-10	90°	. .	. .	90°	. .	. .	80°	. .	. .	25	30to32	.052
25	"	"	50	. .	1-10	"	I	1-10	160°	. .	. .	152°	93° 1′	. .	140°	89° 24′	. .	100	95 to 100	.031
26	"	"	8	. .	1	None.	D	1	19°	. .	. .	16°	. .	. .	16°	. .	. .	10	10	.291
27	"	"	10	. .	½	"	D	½	38°	. .	. .	38°	. .	. .	38°	. .	. .	20	22	.163
28	"	"	12	. .	¼	"	D	¼	75°	. .	. .	74°	. .	. .	70°	. .	. .	40	45	.028
29	"	"	20	. .	⅛	"	D	⅛	95°	. .	. .	90°	. .	. .	80°	. .	. .	80	90	.026
30	"	"	30	. .	1-16	"	D	1-16	110°	. .	. .	108°	. .	. .	95°	. .	. .	160	170	.010
31	Jas. W. Queen & Co.	Henry Crouch, London, Eng.	12	. .	2	"	D	2	15°	. .	. .	17°	. .	. .	17°	. .	. .	5	5½	1.173
32	"	"	12	. .	1½	"	D	1½	20°	. .	. .	23°	. .	. .	23°	. .	. .	6.67	7	.737
33	"	"	12	. .	⅔	"	D	⅔	30°	. .	. .	25°	. .	. .	25°	. .	. .	15	15	.395
34	"	"	7	25	1	"	D	1	16°	. .	. .	14°	. .	. .	14°	. .	. .	10	11	.780
35	"	"	12	. .	1	"	D	1	25°	. .	. .	20°	. .	. .	20°	. .	. .	10	10	.415
36	"	"	18	. .	½	"	D	½	40°	. .	. .	50°	. .	. .	40°	. .	. .	20	22.5	.102
37	"	"	13	50	¼	"	D	¼	100°	. .	. .	100°	. .	. .	90°	. .	. .	40	50	.015
38	"	"	28	. .	¼	Coll. mov. back lens.	D	¼	100°	. .	. .	110°	. .	. .	80°	. .	. .	40	45to55	.024
39	Bausch & Lomb Optical Co.	Bausch & Lomb Optical Co. '79.	18	. .	2	None.	D	2	20°	. .	. .	22°	. .	. .	22°	. .	. .	5	5	.870
40	R. B. Tolles.	R. B. Tolles, Boston, '79.	80	. .	⅛	Coll. mov. back lens.	I I	⅛	. . . .	. . . .	120	180° 180°	. . . .	105° 110°	180° 180°	. . . .	105° 110°	80 80	82–100 80–100	.012 .015

Explanatory Notes.—**The angle** of Aperture is measured with Moelier's Balsam-mounted *Probe Platte* in Focus. Collar adj. for best d

Nominal amplifying power is that of simple lens of Nominal Equivalent Length at 10 inches.

Actual amplifying power is ascertained by measuring the image of a Rogers' micrometer at 10 inches from front l

The U. S. inch is the unit of measurement used. The *Probe Platte* is J. D. Moeller's Balsam mounted.

All tests made with Tolles' ½ inch Solid Eye piece, unless otherwise noted; and all on Tolles-Blackham stand.

Flatness of Field is indicated by figures 1 to 6, 6 being for absolute flatness.

BJECTIVES FOR THE MICROSCOPE,

NED BY GEO. E. BLACKHAM, M. D., DUNKIRK, N. Y.

SCRIPTION.					RESULTS OF MEASUREMENTS AND TESTS.																		
Immersion.	Equivalent Focal length.	ANGLE OF APERTURE			Extreme Angle for Admission of Light			True Aperture Extreme Angle for Good Definition			Nominal Amplifying pow'r	Actual Amplifying power.	Frontal Distance.	Working Distance.	Clear op. Front Lens.	Diameter of Field	Flatness of Field.	Chromatic Correction.	No. Resolved on P. Platte.	Lines per 1-1000 on same	No. Glimpsed on P. Platte.	Lines per 1-1000 inch.	Remarks.
		Air.	Water.	Balsam.	Air.	Water	Balsam.	Air.	Water.	Balsam													
	1 in.	30°	. .	. .	30°	. .	. .	30°	. .	. .	10	10	.309	.307	.360	.034	5½	Slightly Under.	4	24.5	5	26	. . . .
	⅙	180°	. .	95°	180°	114° 35′	95°	180°	114° 35′	95°	60	54to75	.017	.015	.031	.006	5½	"	20	95.5	. .	. . . .	Glycerine Immersion.
	¼	110°	. .	. .	108°	. .	. .	108°	. .	. .	40	45	.015	.013	.077	.007	4½	"	11	47	13	53.5	. . . .
	1-5	108°	. .	. .	108°	. .	. .	100°	. .	. .	50	50	.012	.010	.080	.006	5½	"	13	53.5	14	62	. . . .
	1	36°	. .	. .	36°	. .	. .	36°	. .	. .	10	8.33	.416	.414	.400	.040	5	"	3	16	4	24.5	. . . .
	4-10	110°	. .	. .	110°	. .	. .	100°	. .	. .	25	25	.021	.019	.200	.013	5½	"	11	47	13	53.5	. . . .
	3-5	. .	. .	. .	36°	. .	. .	36°	. .	. .	16⅔	14	.281	.279	.210	.025	5½	"	4	24.5	5	26	. . . .
	¼	90°	. .	. .	90°	. .	. .	80°	. .	. .	40	36	.018	.016	.105	.010	5½	"	11	47	12	61.6	. . . .
	⅓	. .	108°	. .	180°	108°	90°	180°	99° 38′	84°	80	85to90	.015	.013	.075	.004	5	"	14 & 15	62 58	18	86.2	. . . .
	1-11	. .	108°	. .	180°	108°	90°	180°	102° 13′	86°	110	100 to 112	.012	.010	.055	.003	5	"	14 & 15	62 58	18	86.2	. . . .
	1	30°	. .	. .	33°	. .	. .	33°	. .	. .	10	10	.308	.306	.240	.033	4½	Slightly Over.	3	16	4	24.5	. . . .
	½	65°	. .	. .	65°	. .	. .	65°	. .	. .	20	22	.050	.048	.260	.015	4	"	9	46.4	10	49.2	. . . .
	¼	105°	.	. .	100°	. .	. .	100°	. .	. .	40	35	.016	.014	.108	.009	5	Slightly Under.	13	53.5	14	62	Compensation adjustment by varying thickness of internal film of glycerine.
	⅙	170°	.	. .	140°	. .	. .	120°	. .	. .	60	60	.008	.006	.044	.006	4¾	"	16	67	17	63	. . . .
	½	85°		. .	85°	. .	. .	85°	. .	. .	20	18½	.036	.034	.260	.018	5	"	11	47	13	53.5	. . . .
	½	85°	.	. .	98°	. .	. .	92°	. .	. .	20	20to22	.026	.024	.240	.015	5	"	13	53.5	14	62	. . . .
	⅔	34°	.	. .	32°	. .	. .	32°	. .	. .	15	15	.199	.197	.200	.022	5¼	"	4	24.5	5	26	. . . .
	3-10	110°		. .	120°	. .	. .	102°	. .	. .	33.3	33.5	.030	.028	.160	.009	5	"	13	53.5	14	62	. . . .
	1-5		.	.	115°	. .	. .	81°	. .	. .	50	50	.022	.020	.100	.007	5	"	14	62	15	58	. . . .
	1	50°	.	.	50°	. .	. .	50°	. .	. .	10	10	.137	.135	.300	.034	5½	"	8	33.1	9	46.4	. . . .
	3	12°	. .	.	12°	. .	. .	12°	. .	. .	333	3.	2.442	2.440	.520	.120	4¾	"	1	3.7	2	13	. . . .
	1½	23°	. .	. .	23°	. .	. .	23°	. .	. .	167	6.67	.652	.650	.460	.051	5	"	2	13	3	16	. . . .
	⅔	32°	. .	. .	32°	. .	. .	32°	. .	. .	15	15	.325	.323	.260	.022	5½	"	3	16	4	24.5	. . . .
	4-10	90°	. .	. .	90°	. .	. .	80°	. .	. .	25	30to32	.052	.050	.130	.011	5½	"	10	49.2	13	53.5	. . . .
	1-10	160°	. .	. .	152°	93° 1′	. .	140°	89° 24′	. .	100	95 to 100	.031	.029	.024	.003	5	"	14	62	16	67	. . . .
	1	19°	. .	. .	16°	. .	. .	16°	. .	. .	10	10	.291	.289	.300	.034	5½	"	2	13	3	16	. . . .
	½	38°	. .	. .	38°	. .	. .	38°	. .	. .	20	22	.163	.161	.200	.015	5	"	4	24.5	5	26	. . . .
	¼	75°	. .	. .	74°	. .	. .	70°	. .	. .	40	45	.028	.026	.086	.008	4½	"	10	49.2	11	47	. . . .
	⅛	95°	. .	. .	90°	. .	. .	80°	. .	. .	80	90	.026	.024	.037	.004	4½	"	11	47	12	61.6	. . . .
	1-16	110°	. .	. .	108°	. .	. .	95°	. .	. .	160	170	.010	.008	.020	.002	4½	"	14	62	15	58	. . . .
	2	15°	. .	. .	17°	. .	. .	17°	. .	. .	5	5½	1.173	1.171	.440	.062	5½	"	2	13	3	16	. . . .
	1½	20°	. .	. .	23°	. .	. .	23°	. .	. .	6.67	7	.737	.735	.400	.047	5½	"	3	16	4	24.5	. . . .
	⅔	30°	. .	. .	25°	. .	. .	25°	. .	. .	15	15	.395	.393	.220	.025	5	"	3	16	4	24.5	. . . .
	1	16°	. .	. .	14°	. .	. .	14°	. .	. .	10	11	.780	.778	.300	.032	5½	"	1	3.7	2	13	. . . .
	1	25°	. .	. .	20°	. .	. .	20°	. .	. .	10	10	.415	.413	.280	.032	5½	"	2	13	3	16	. . . .
	½	40°	. .	. .	50°	. .	. .	40°	. .	. .	20	22.5	.102	.100	.240	.015	5½	"	8	33 1	9	46.4	. . . .
	¼	100°	. .	. .	100°	. .	. .	90°	. .	. .	40	50	.015	.013	.070	.006	5½	"	11	47	12	61.6	. . . .
	¼	100°	. .	. .	110°	. .	. .	80°	. .	. .	40	45to55	.024	.022	.062	.006	5½	"	11	47	12	61.6	. . . .
	2	20°	. .	. .	22°	. .	. .	22°	. .	. .	5	5	.870	.868	.440	.067	5½	"	2	13	3	16	. . . .
	⅛	. . . .	. . . .	120	180° 180°	. . . .	105° 110°	180° 180°	. . . .	105° 110°	80 80	82–100 80–100	.012 .015	.010 .013	.020 .020	.0035 .0035	5½ 5½	"	20 20	95.2 95.2	. . . .	. . . .	Glycerine Immersion. Cedar Oil "

r's Balsam-mounted *Probe Platte* in Focus. Collar adj. for best definition Tolles' ½ inch Solid Eye piece.
of Nominal Equivalent Length at 10 inches.
suring the image of a Rogers' micrometer at 10 inches from front lens with Gundlach's Periscopic Micrometer Eye piece.
. The *Probe Platte* is J. D. Moeller's Balsam mounted.
ece, unless otherwise noted; and all on Tolles-Blackham stand.
5 being for absolute flatness.